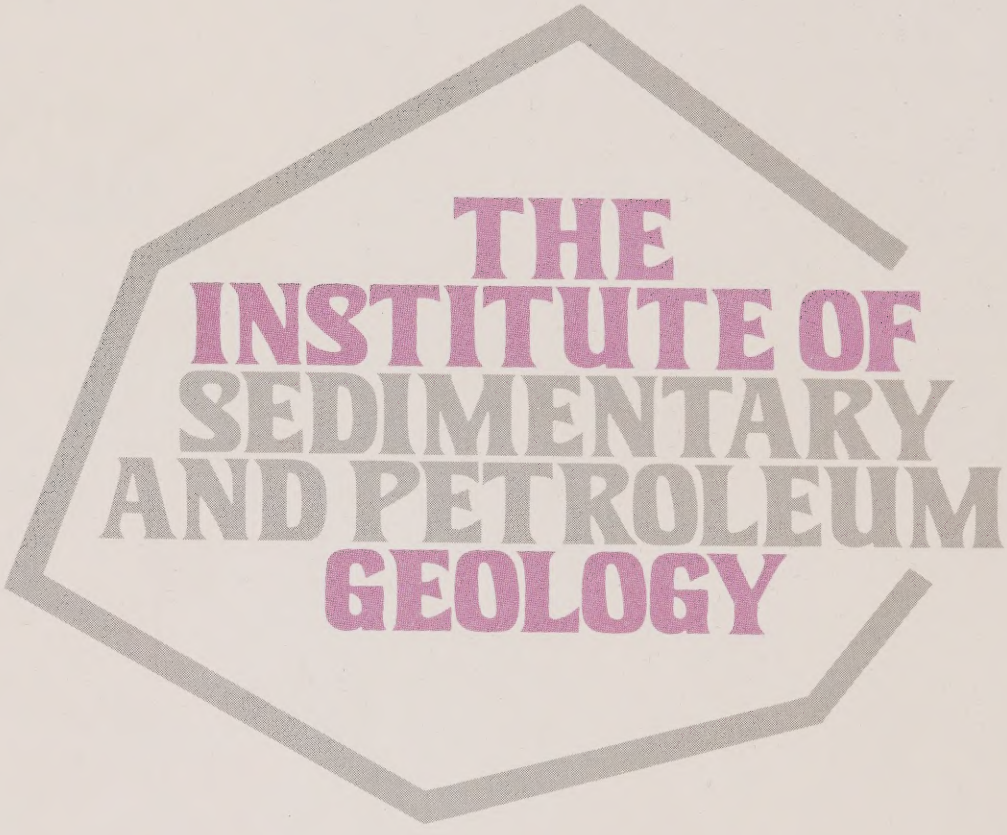
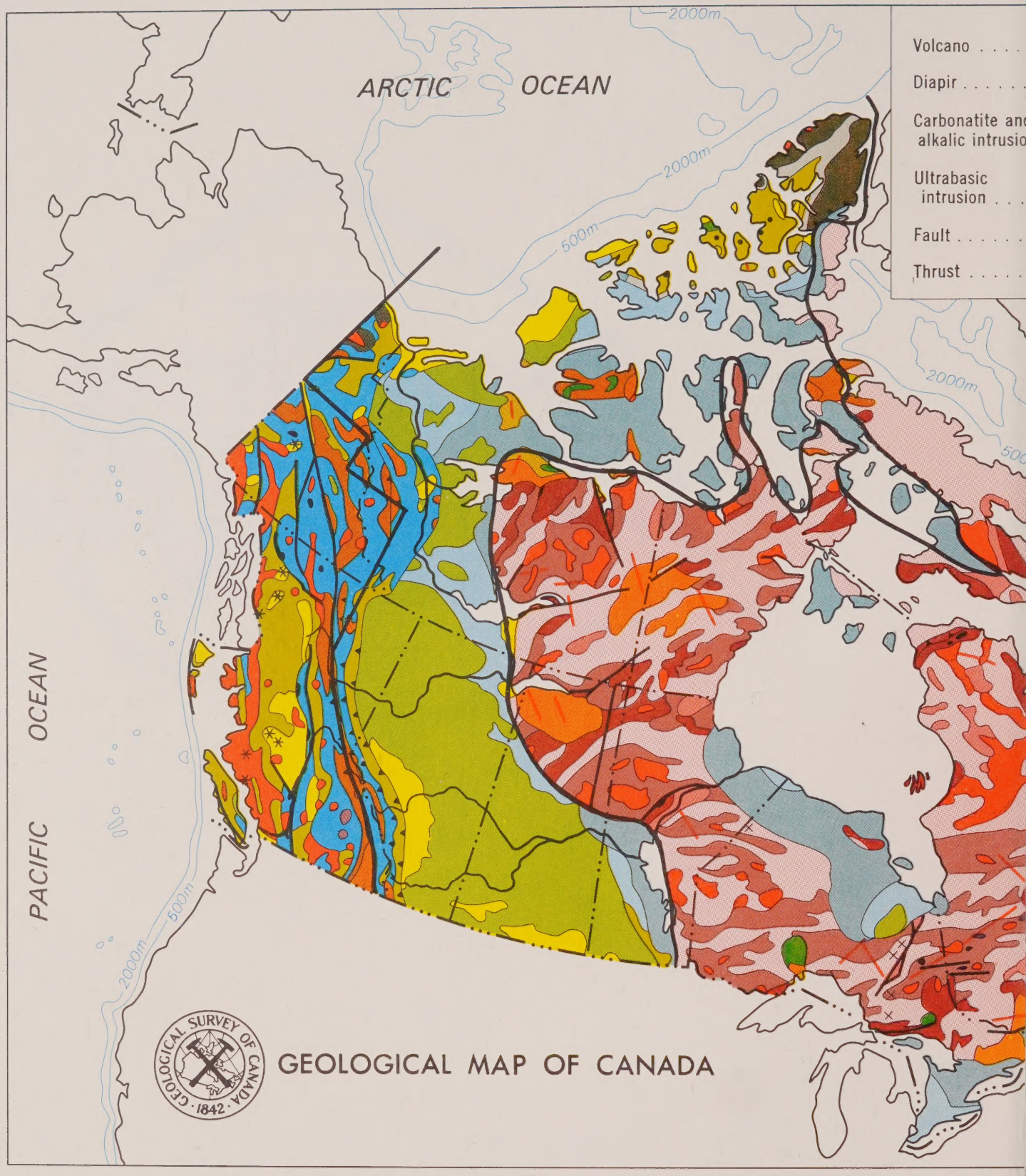
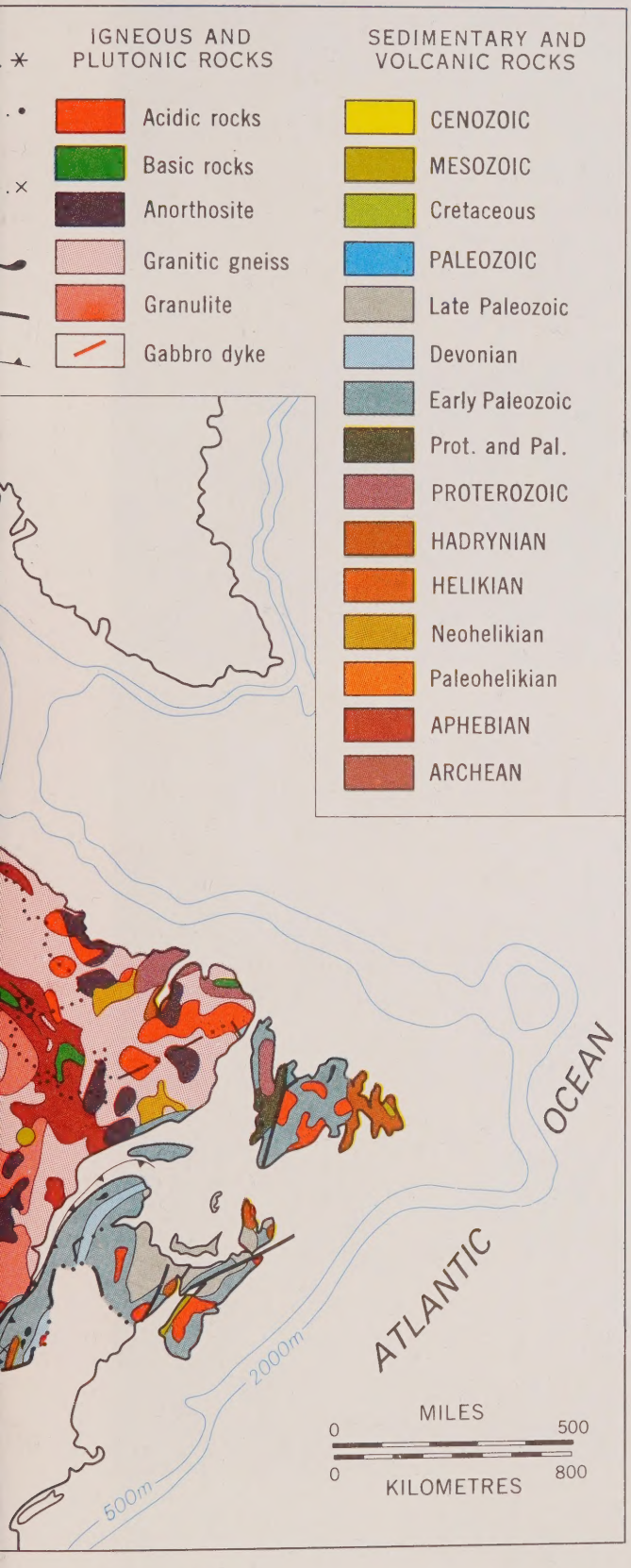
THE INSTITUTE OF SEDIMENTARY AND PETROLEUM GEOLOGY

DEPARTMENT OF ENERGY, MINES AND RESOURCES • OTTAWA, CANADA



DEPARTMENT OF ENERGY, MINES AND RESOURCES
GEOLOGICAL SURVEY OF CANADA
Donald S. Macdonald, Minister
J. Austin, Deputy Minister


ARCTIC OCEAN
PACIFIC OCEAN
2000m
500m
Volcano
Diapir
Carbonatite and alkalic intrusio
Ultrabasic intrusion
Fault
Thrust
GEOLOGICAL SURVEY OF CANADA · 1842 ·
GEOLOGICAL MAP OF CANADA



A land with natural resources in abundance. That's how most of us see Canada. However abundant these resources are, they are not limitless and there is an urgent need for investigation and research to determine the quality, quantity and character of our natural wealth. Such basic knowledge is vitally important to the Department of Energy, Mines and Resources, which has the task of formulating energy and mineral resource policy that will ensure the efficient use and conservation of these resources for all Canadians.

The Department's Institute of Sedimentary and Petroleum Geology in Calgary, Alberta, is a key source of comprehensive and up-to-date information on the energy resources of the sedimentary basins of western and northern Canada. A division of the Geological Survey of Canada, the Institute is responsible for studying the bedrock geology of this great area, which contains almost all of Canada's known oil and natural gas resources and remains highly prospective for both. It also contains most of our coal reserves. These fossil fuels, formed from organic material — marine and nonmarine plant and animal life — trapped and buried with sediments laid down millions of years ago, are found in the sedimentary rocks of the Western Sedimentary Basin, the Arctic Lowlands and the Arctic Islands.

Sedimentary rocks such as shale, sandstone and limestone begin at the edge of the Precambrian (Canadian) Shield in Manitoba and thicken to several miles at the foot of the Rockies and beneath them. They stretch north to the Arctic Ocean and continue under the Beaufort Sea. While relatively thin in the Arctic Lowlands, the strata (layers of rock) reach a thickness of up to seven or eight miles in parts of the Arctic Islands. Farther north, younger strata were deposited in the Sverdrup Basin area where the maximum thickness of any one section is about seven miles and the total thickness is close to ten miles.

As well as the fossil fuels found, there are deposits of uranium and of other minerals including large reserves of sulphur and potash. Of additional importance are the deposits of sand and gravel, essential for the construction of roads, pipelines and airports.

It can be said that this area, particularly the northern and Arctic regions, will likely also contain a considerable part, if not most, of the future reserves of energy resources yet to be found, with the exception of hydroelectric potential.

1

2

1. The Institute
2. Library reading room
3. Entrance rotunda

3

THE INSTITUTE

The Leduc discovery in central Alberta put Canada on the world oil map in 1947 and generated a wave of exploration for oil and gas across the western provinces. With it came sudden and unexpected requests for geological information to place the new data into perspective. Field parties of the Department's Geological Survey of Canada had been investigating the area since the last century, but now more detailed information was needed. The Geological Survey responded to the new challenge by opening a Calgary office in 1950. Ten years later it made plans for the expansion of the Calgary office which led to the establishment of the Institute.

The Institute of Sedimentary and Petroleum Geology was opened in 1967 in Calgary. The main task of its scientific staff was to explore the geology of the sedimentary basins in the west and north; to carry out investigations and research in petroleum geology and geochemistry, sedimentary petrology, clay mineralogy and paleontology, and to maintain laboratories, a storehouse of drilling cores and rock samples, and a library.

Calgary is a natural centre for the Institute. It is the home of some 2,000 geologists, and hundreds of other earth scientists, such as geophysicists, geochemists and engineers. It is the headquarters of most oil companies in Canada and the site of many related research organizations.

The Institute is housed in a $2,500,000 building on a 15-acre site adjacent to the University of Calgary campus. The strength of the Institute lies in its staff of respected scientists whose field and laboratory investigations are recorded in published maps and reports. To back up staff field work, it has some of what are recognized to be the finest laboratories in Canada: organic and inorganic chemistry, clay mineralogy, sedimentary petrology, and macro- and micropaleontology.

The reputation of the Institute is such that renowned researchers have joined the staff and foreign scientists often visit to do research.

The Institute can call on highly competent specialists who frequently are acknowledged international authorities in their respective fields. It can count also on the services of the many specialists in very narrow fields of science, without whom no meaningful research could be accomplished. To take one field as an example: a remnant of one particular fossil, of a type that is not often found in Canada, may have been found in an isolated well. Such a fossil may have been the lifetime concern of three or four men, or even only one man in North America, or in the world, and the specimen will be sent to him. He will be the only man who can determine its age and environment with absolute certainty. His result could decisively influence the analysis of a whole geological area, say the Sverdrup Basin, in which the fossil was found.

A CLEARING HOUSE OF GEOLOGICAL DATA

The Institute is a focal point where other federal and provincial agencies, resource-dependent industries, any citizen, be he a scientist or layman, can get the available information on the geology of the area for which the Institute is responsible.

It is a clearing house for the masses of data received by it as a result of private exploration, or its own field work. First, the millions of facts are joined into a coherent and undistorted picture of the geological history of the sedimentary basins. Next, all of this information is marked or indexed and filed. Then any desired information on the general or specific geology of an area in the region is ready for easy retrieval to be put to use in defining potential or explaining phenomena.

The staff of the Institute can classify any new data brought to it — cuttings from a wildcat well, or a gas sample. This is vitally important for both scientists and industry. An individual company drilling in, or investigating, a specific area for some time may have the most information locally, but generally the opposite is true. Facts that puzzle can only mislead, but isolated data placed in the proper context can become a signpost to success.

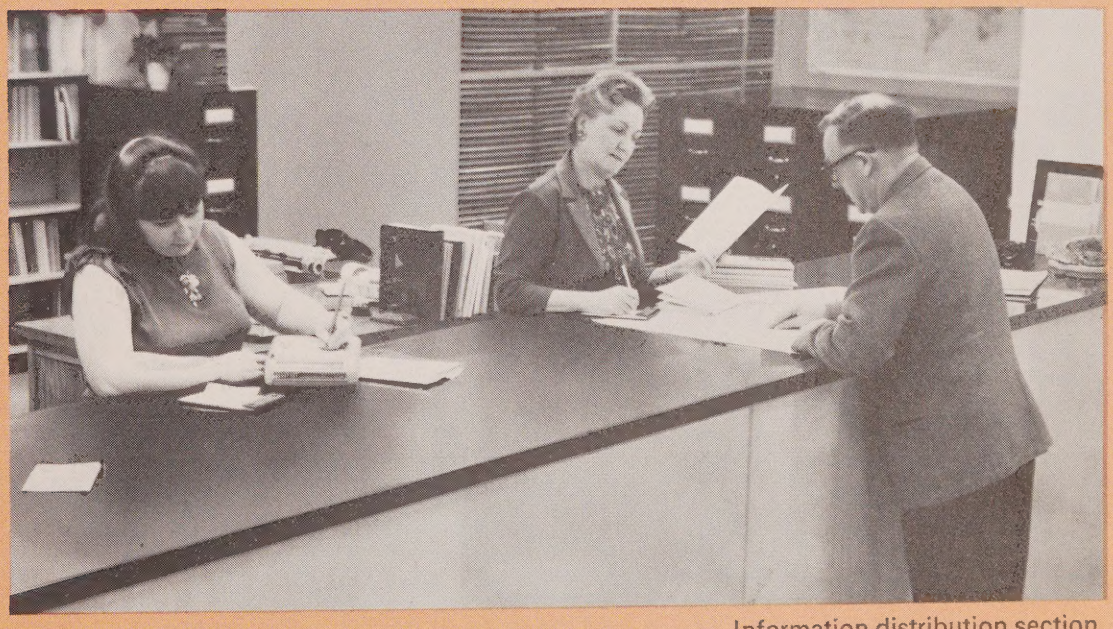
When information is sparse, it is difficult to place the data gained from a borehole into the geological framework. The answers to many questions are necessary to ascertain whether conditions are favorable for the discovery of oil and gas. For instance, how old are the strata found at various levels in the borehole? Are the sands at a certain level marine, or were they formed in a river channel on land? Were there mountains nearby when they formed? Was there a large ocean beyond this sand deposit? Did it form during a warm or a cold climate? Is it possible to say whether similar sand deposits might be found elsewhere?

These questions can be answered with a fair degree of certainty. But usually the picture is much more complicated, and only a trained earth scientist can even begin to grasp its true meaning.

It is in this context that the Institute is assisting government to build a healthy oil and gas industry in the interests of all Canadians. The Department of Energy, Mines and Resources uses the information received from the Institute in the formulation of its resource management and energy policies. For instance, the Institute keeps the Department informed on the meaning of a new discovery, such as the gas and oil discoveries in the Arctic Islands and the oil and gas discoveries in the Mackenzie Delta. Do these discoveries hold promise for even greater discoveries in the near future? Is the potential there? The answers are of vital importance for government planning. Should the export of gas

and oil be allowed, or should the deposits be preserved for future Canadian use? Can Canada become a major supplier of gas and oil for this continent? How well can our needs be taken care of if political happenings lessen our overseas supplies of oil? Or: What type of gas will be found where? Will it contain much sulphur and demand the construction of additional gas processing plants? Will the present sulphur glut have worsened 5, 10, 15, 20 years from now?

Similar questions will be asked by any of the several regulatory agencies that control orderly exploration, development and exploitation of the federal Crown Lands for which industry has entered into some form of rental agreement. The Institute itself only advises, it does not regulate, but it is usually ready with the answer, or it will get it quickly.



Information distribution section

FIELD WORK

On the Mainland

The Institute has given top priority to the scheduled completion of a broad reconnaissance coverage of the unmapped parts of its territory by 1976.

To do this, it has included, in its field studies, large aircraft-supported 'Operations' in the Yukon, Northwest Territories and the northern Rockies. Such operations are combined studies and include experts in stratigraphy, paleontology, structural geology and, perhaps, geophysics and surficial geology. One scientist on the operation handles logistics and coordination.

The studies take two or more years to complete. During this time, the Institute makes the information available to the public through the various types of reports and preliminary maps of the Geological Survey.

Operations Liard and Smoky were two programs in the northern Rockies and Foothills. Operation Liard extended from the British Columbia-Yukon border, 60 degrees north latitude, south to 57 degrees north latitude, and Operation Smoky continued south to about 55 degrees north latitude. The object was to investigate in detail the rock layers within the region, to establish the framework of the strata, and to compare and relate this to the geology of the Rockies to the south.

Personnel on Operation Porcupine examined the mainland area of the Yukon and Northwest Territories north of 65 degrees north latitude and west of 132 degrees west longitude, an area of about 80,000 square miles, extending north to the Arctic Ocean. The goal was to study the chronological order in which strata were laid down and to look into the complex structure of the various mountain systems in the region.

Scientists on Operation Norman investigated an area of about 145,000 square miles to the east of that covered by Operation Porcupine during the period 1968 to 1971. This area extended between 64 degrees north and the Arctic Ocean and between 119 and 132 degrees west longitude. Their work included bedrock mapping, studies of the rock layers, examination of glacial and surficial deposits and an evaluation of the area's economic potential.

In the Arctic

Reconnaissance geology in the islands, which began in 1947, is virtually complete, allowing scientists to move on to more detailed studies. The geological history and a framework for identifying and naming the various strata have been established. These, with the published knowledge of the distribution of potentially oil- and gas-bearing sedimentary basins, have contributed to the great increase in oil exploration in the Arctic Islands and the Mackenzie Delta.

In the early 70's the Institute issued a comprehensive report accompanied by colored maps

Geological map of part of the Arctic Islands

More detailed geology of part of Fosheim Peninsula, Ellesmere Island

on the more than 200 million-year-old Carboniferous and Permian rock formations of Axel Heiberg Island and western Ellesmere Island. Although the report and its compilation was the work of one man, the actual field geology engaged several scientists over a few years. Another report gives the results of a study conducted into the geology of the Bathurst Island group and Byam Martin Island.

In 1972 the Institute neared completion of an airborne geological study of southwest Ellesmere Island and western Devon Island. Parts of this area had been covered in 1955 during Operation Franklin, but more data are now required because of the greatly increased pace of petroleum exploration.

Updating information on the region is a continuing process using both surface and subsurface data as it becomes available through the search for petroleum. This not only leads to an increased understanding of the geology in the Arctic region, but it will result in more efficient mineral exploration and extraction and the ability to evaluate reliably the mineral potential of the region.

Basin Analysis

Basin analysis is, from a geologist's point of view, the crowning effort of the geological investigation of a basin, such as the Sverdrup Basin in the Arctic Islands. It ties together many individual studies; it analyzes the history of a basin, its contents, its potential. The Institute of Sedimentary and Petroleum Geology is well equipped to do this.

Such a major undertaking takes many years to conclude. The analysis proceeds for each basin from the beginning of its exploration, and it is updated as more information becomes available. Each basin is analyzed in this manner, the Sverdrup Basin, for instance, or the Beaufort Sea Basin at the northern coast of the Northwest and Yukon Territories. Each basin has undergone its own history; it has received more or less sediment than the next basin, different types of sediments at different times, and each basin has undergone different tectonic processes, such as folding and faulting of the sediments. Each will have a potential for oil and gas that is very different from that of another basin.

How is this highly complex and involved task accomplished? First, it is a team effort, engaging the services of many experts and several area geologists. A correlation of all the findings will allow an assessment of the happenings within a basin during each geological time interval, which must be thought of as very long periods of time, each involving many millions of years. During each of these intervals, different rocks will have accumulated in different parts of the basin. For instance, rocks that serve as a

1

2

1. A typical light camp for geologists working in the Arctic Islands
2. A base camp for ISPG staff working in the Sverdrup Basin area of the Arctic Archipelago

source for oil and gas, such as shales, might occur in one part of the basin. Ideally, reservoir rocks, such as porous sands and reefs, may occur in the same interval close to them, allowing oil and gas to migrate into them over long periods of time. Once inside the reservoir rocks, oil and gas may be trapped in structures and held in by impermeable barriers. What is important here is the 'assessment' of these possibilities. For instance, will gas and oil be found in a certain interval? Will they occur in certain parts of the basin? Another important aspect of basin analysis is the orientation of data in the basin. A single wildcat well is useless to exploration if the meaning of the data obtained from it cannot be ascertained. The Institute can put isolated data into their context.

The Institute has intensified its basin analysis studies of northern and Arctic petroleum basins to meet the need for data for federal policy decisions. Arctic Canada may well become one of the major oil regions of the world. The federal government has entire jurisdiction over this region so it is faced with the responsibility both to encourage and to control the surge of activity. Regulations must be based on detailed geological knowledge.

Coal

After some years of being the Cinderella of the energy packet, coal has again become an eagerly sought fuel resource.

The Institute plans to initiate studies of coal potential. One of these new projects is a joint drilling program of the Geological Survey of Canada with the Province of Saskatchewan. The object of this two-year field program is to evaluate lignite coal resources in southern Saskatchewan suitable for strip mining and to establish whether or not economic coal seams are present.

LABORATORY WORK

All field work by officers of the Institute is supported by laboratory work including X-ray fluorescent analysis, macropaleontology, micropaleontology, chemical analysis and the production of thin sections or rock samples for petrographic study under the microscope.

Because of the increasing importance of geochemical studies, a program in organic geochemistry has been started to assess the oil and gas potential in relatively unknown areas. Fine-grained rocks from wells and outcrops show traces of hydrocarbon gases, indicating the type and amount of petroleum that may be found before any actual discoveries are made. Institute scientists run gas analyses on samples from selected boreholes in Alberta, Saskatchewan, and Northwest Territories and all wells drilled in the Arctic Islands, and they determine total carbon and organic carbon content by high-temperature combustion. In addition to identifying petroleum source rocks, the use of organic geochemical reconnaissance in the Arctic will aid in basin analysis and enable Institute scientists to correlate their results with the geochemical information generated by petroleum companies operating in northern Canada.

In some geochemical projects, Institute scientists are working jointly with industry and l'Institut français de pétrole in France. Their object is to correlate chemical and geological data in an effort to group oil types and establish the interrelationship of source rocks with hydrocarbon reservoirs to gain a better understanding of how and why oil is generated and accumulated.

The Institute's paleontology subdivision dates rocks and determines the environment of the time during which they were deposited, by examining the organic remains contained in the rocks. Such remains include microfossils that can be seen only with a microscope and macrofossils that are visible to the naked eye, but require microscopes for intensive study. Plant microfossils and invertebrate macrofossils are the most widely distributed and therefore the most valuable. If enough fossils are preserved, accuracy of dating is well within two per cent. But their use necessitates a detailed knowledge of the biological structure, family classification, life habits and evolution of the various groups of organisms.

The examination of fossils brings to light a number of facts about circumstances at the time of deposition : marine or non-marine conditions, water depth, salinity, nature of the bottom and water turbulence. As a result of the assessment and dating of ancient environment within a region, scientists are able to reconstruct the geography of the region during different eras and produce a complete geological history of the region.

1

2

3

1. Sedimentary petrology laboratory
2. Clay mineralogy laboratory
3. Chemistry laboratory

Outside Liaison

Liaison with research scientists outside the Geological Survey is a two-way street, saving time and money, benefiting all. It is logical, for example, to send out fossil samples to an expert who has studied a special type of fossil for years rather than to hire him on occasion or do the work at the Institute. The specialist, in return, likes nothing better than to have access to such a specimen, thus advancing his own research. No charge is involved in either case.

A province with its own geology staff will not need much help from the Institute. Others will. Whatever the case, the Institute will not duplicate work already done by provincial geologists, or a reputable scientist. It will standardize all information for indexing or for a project, such as a series of maps that have to be drawn to one scale, using a common legend and set of symbols.

Research costs are high; consequently, any project will follow the most direct route, utilizing available resources that may not always be at the Institute. For instance, the Institute staff uses the electron microscope of the University of Calgary and the University's researchers in turn use special facilities of the Institute, such as the X-ray diffraction equipment.

Universities are being encouraged to pursue special research projects selected and supervised by the Institute permitting graduate students, in particular, to research theses that they might otherwise not be able to attempt. This cuts down the Institute's costs and provides gainful employment.

INSTITUTE SERVICES

The Institute has custody of drilling cores, samples, and other data resulting from exploration activities by industry in Yukon Territory, mainland Northwest Territories and Arctic Islands and for drilling samples from all provinces and territories of Western Canada except Alberta. Samples and cores from the northern territories are submitted to federal administration in conformity with regulations.

Personnel of the Institute act as consultants on a variety of matters and provide information required by other organizations, industry and the general public.

Services to Public

Core and Sample Repository and Examination areas—About 10,000 boxes of cores from all wells drilled in areas under federal government jurisdiction are stored in the Institute and are available to the public for free examination. These areas include the whole of the Yukon and Northwest Territories, the continental shelves, and Hudson Bay. Eight specially designed tables in a room adjacent to the storage area facilitate examination.

Some eight million samples from cuttings of all wells drilled in Western and Arctic Canada also are stored at the Institute. With the exception of samples from Alberta, all are available to the public for free examination in a well equipped examination room that can accommodate 15 visitors. Alberta cores and samples may be examined at the Alberta Energy Resources Conservation Board, which is adjacent to the Institute.

Supplementing this are well files containing all the mechanical logs and other data related to the some 50,000 wells drilled in Western and Arctic Canada.

About 2,200 visitors a year utilize core and sample examination facilities.

Institute Library—The library is the most comprehensive geological research library in Western Canada. It contains literature on the stratigraphy, mineral occurrences, fuel reserves, petroleum and general geology of Canada and many other countries. It is a depository library for the publications of many geological agencies and societies throughout the world. The collection numbers approximately 50,000 items (books, periodicals, and other miscellaneous material, excluding maps) and is arranged according to the Library of Congress classification system. About 500 periodicals are received regularly. The services of a Russian translator are available for the translation of title pages, contents, and captions and for scanning Russian literature at the request of the scientific staff.

1

2

1. Drill core examination room
2. Borehole cutting examination room

Publications—Another service to the public is the publications section, which handles geological maps and reports and aeromagnetic maps of the Geological Survey covering the whole of Canada; topographical maps and the numerous other publications of the Department of Energy, Mines and Resources. Each year, the section distributes about 100,000 items, answers about 3,500 letters and 8,000 telephone calls, and serves more than 4,000 visitors to the publications office.

Internal Services

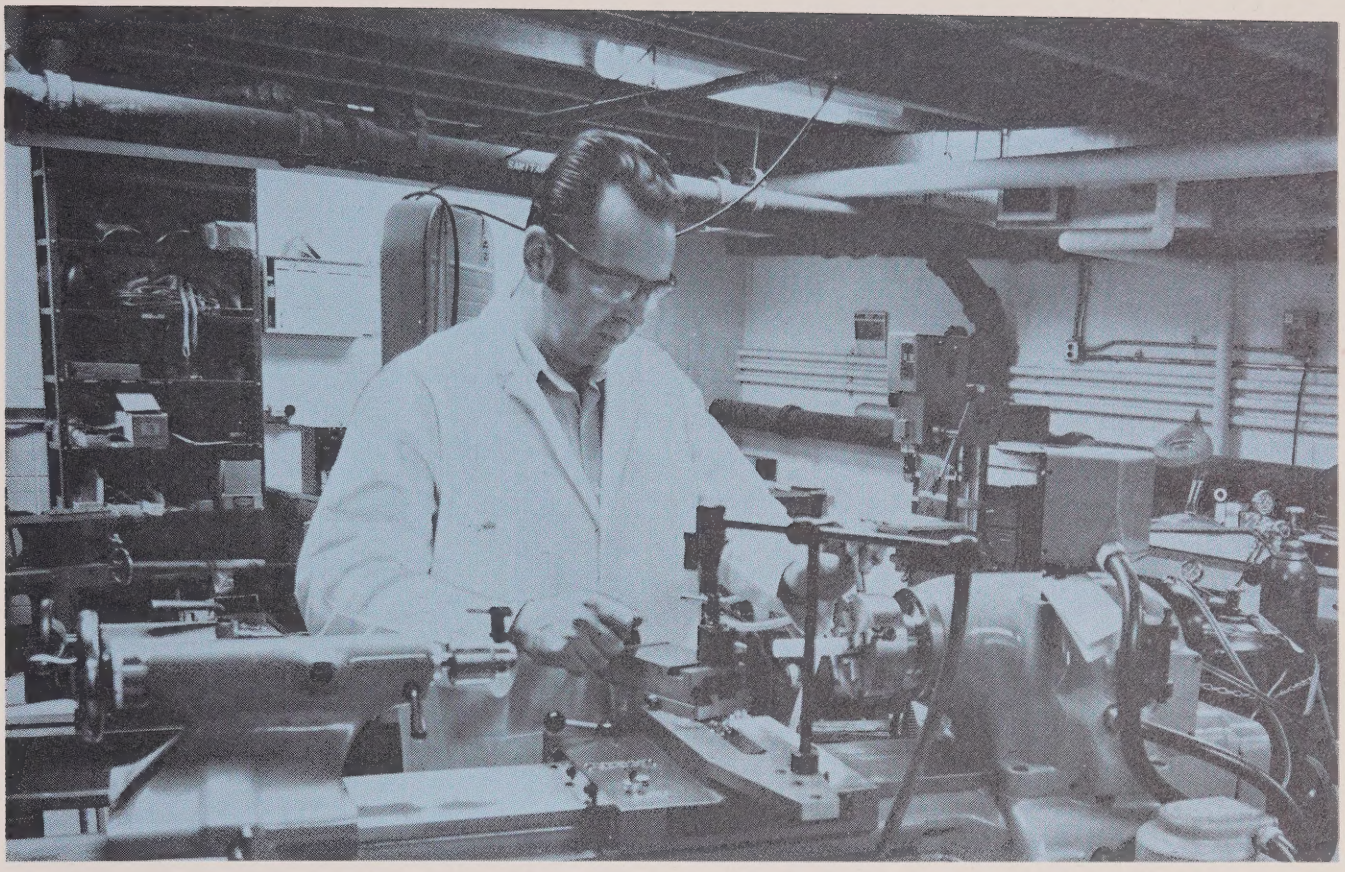
The Institute's cartographic section provides drafting and reproduction services for the scientific staff. It processes the submitted manuscripts through compilation and final drafting until they are ready to be sent to the Ottawa headquarters for printing. The bulk of the work consists of mapmaking, although illustrations are drawn for papers and reports published outside the Institute and slides are made to illustrate papers given by the professional staff.

The lapidary section produces about 2,000 thin sections and many polished sections of rocks for study by scientists. The Institute also has a photographic section and a shop that develops, modifies or repairs laboratory machinery and equipment and repairs and maintains plant equipment.

The Institute's Output

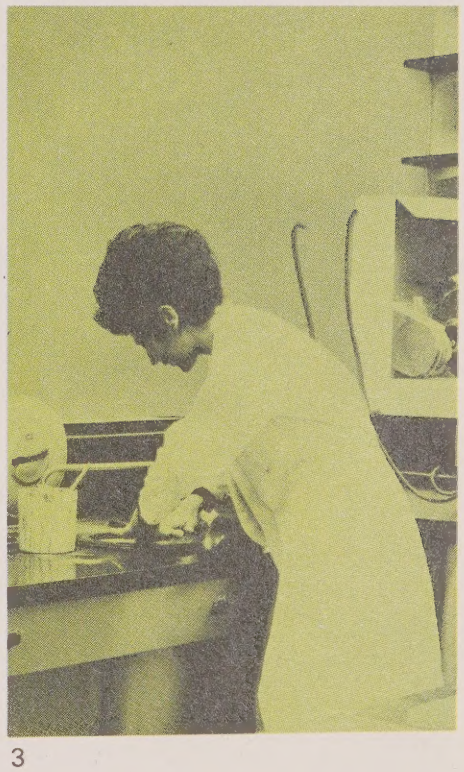
Reports and maps, the visible output of the Institute, are completed to the printing stage in the Institute. Since their preparation is involved and requires a variety of services (e.g., for the construction of maps), preliminary reports and maps are placed on 'open file', to allow the public the earliest possible scrutiny of the material being prepared. Each author of a report or map does his own preparatory work, then passes the material along to two 'critical readers'. One of the readers will know the subject or the subject area, the other will not. If the second reader does not understand the report, it is not accepted. Once critically read, a report is passed to the scientific editor for further scrutiny and processing.

The latest series of geological maps of Canada is being produced as a continuous mosaic, disregarding internal political boundaries, with the Institute originating the maps for its area of jurisdiction. A major project under way by the Geological Survey of Canada is the compilation of a series of maps on a scale of 1 :1,000,000 (about 16 miles to the inch). The reconnaissance phase of mapping has been almost completed, and the Geological Survey is preparing maps on the scale of 1 :250,000 (about 4 miles to the inch) as an inventory of the geology of Canada, which has already been achieved in various degrees for different regions. The maps are based on data derived from both federal and provincial agencies and, in some instances, require updating of available information.



1

2



3

1. Machine shop for instrument building and repair
2. Geological cartography section
3. Preparing thin sections of rocks

"The Specialist — of old"

Modern earth sciences have evolved and split into a great number of special branches, owing to an ever increasing amount of factual knowledge that no one person can any longer hope to possess. A modern field party may no longer be led by just one geologist who collects all of the data himself. Instead, there may be one coordinator assisted by and calling on a team of specialists, such as a paleontologist, a petrologist, a structural geologist, and so on.

Field parties today are much more expensive than in the days of the horse and canoe and the sack of beans, so all projects are under strict cost control. And although the trips are mission-oriented, each with a particular objective, the field geologists still bring home other valuable knowledge. Much information found on the wildlife sensitivity maps, published for the Arctic Islands by the Canadian Wildlife Service, has come from the Institute's men in the field. Two staff members recently found the winter range of the muskox population on Prince of Wales Island, a critical item of information for the future planning of governmental or industrial activity in the area.

Canada's new breed of geologists may be equipped with the most modern facilities, but at heart they are like the geologists of old,—naturalists taking note of everything they see, devoted to understanding and taking stock of what makes Canada wealthy: her resources below and above ground.

Future Programs

The Institute will direct even more of its future programs toward ascertaining the energy potential in the areas for which it is responsible.

Meanwhile, an immense frontier remains to be explored: the seafloor rocks of the channels and continental shelves. As the technological means allow, the Institute will study the geology of these rocks and add the data on resource potential to our national inventory.

Prepared by PUBLIC RELATIONS AND INFORMATION SERVICES